THERMOELECTRIC REFRIGERATED CHAMBERS

PFR Technologies thermoelectric refrigerated chambers are designed to provide cooling for photomultiplier tubes and other electro-optical detectors without the requirement of supplemental cooling materials such as dry ice or LN_2. These chambers cool the tube cathode to approximately 20, 40, 50, 60, or 70°C below ambient (air or liquid), depending on the unit type. Associated power supplies with optional temperature controllers provide temperature regulation of the tube cathode, holding the temperature stable to +/- 0.1°C within the selection range of the unit type being used.

Some units, including the Multi-Stage series, include a heated double-paned insulating window, which serves as a thermal isolator, preventing frosting or dewing of any surface in the light signal path. All units include a non-fogging double-paned evacuated window (except convection-cooled, which include a single pane) which, together with the standard photocathode location, provides optimum cathode temperature and uniformity.

Each cooled housing contains a high permeability magnetic shield as an integral element. Magnetic shielding is optimally configured, extending the recommended 1/2x tube diameter beyond the PMT. Electrostatic shielding is carefully designed to protect the photocathode and dynode system from the adverse effects of external electrostatic fields. Internal automatic connection is made between the tube socket assembly and the housing. This design makes it possible to put the shield at high negative voltage or at ground, simply by using the appropriate interchangeable tube socket assembly. Furthermore, RFI shielding is designed and rigorously tested to provide full protection from RF interference for applications such as photon counting.

The modular tube socket assemblies contain the tube socket, dynode resistor string, and coaxial anode and cathode connectors. The unique system design allows quick interchange of tubes, and will withstand severe handling without damage as there are no moving parts. Furthermore, the new PHOTOCOOL™ series is composed of discrete components which are interchangeable within the PHOTOCOOL™ product range. These components include 4 versions of the S600 power supply, 4 interconnect cable types, all PHOTOCOOL™ housings, all PFR socket assemblies, and all PFR windows.

All thermoelectric units (except convection units) can be operated in any plane without degradation of performance. The units are light-weight and ideally suited for remote station applications where unattended operation is necessary.

The following symbols may be present on equipment and/or instruction manuals:

Symbol	Publication	Description
	ISO 3864, No. B.3.6	Caution-Risk of Electric Shock
	ISO 3864, No. B.3.1	Caution-Refer to Accompanying Documents
	ISO 417, No. 5019	Protective Conductor Terminal
1	IEC 417, No. 5007	On (Supply)
0	IEC 417, No. 5008	Off (Supply)
	IEC 417, No. 5016	Fuse

54301/9903

⚠CAUTIONS:

⚠ **Be sure to attach a solid ground lead to the ground prong of the power supply line cord. Do not operate without the chamber grounded to a firm ground point.**

⚠ **The voltage input selector in the rear of the S600 Power Supply must be set to the appropriate line voltage before operation. Failure to set the required voltage will void all expressed or implied warranties, and may cause damage to the equipment.**

⚠ **To avoid possible shock hazards, turn off all power (high voltage, line voltage, etc.) before any installation, removal or adjustment of the system or any components.**

⚠ AIR HEAT-EXCHANGED UNITS

Heat losses from the thermoelectric device plus heat pumped from the chamber MUST be expelled by the fan (except convection units). The unit could be severely damaged if operated without the fan functioning.

Most air heat-exchanged units have a thermal overload switch on the heat exchanger. This switch blows the power supply output fuse during improper operation of the heat exchanger. However, its purpose is as a safety device and not an operational switch to permit chamber use without air flow. Do not operate with air intake ports or outlet screen covered, or with the fan disconnected. A clear space, at least four inches deep, should be provided between the air outlet and any solid object such as a wall or bench top.

⚠ LIQUID HEAT-EXCHANGED UNITS

Heat losses from the thermoelectric device plus heat pumped from the chamber MUST be expelled by the liquid-cooled heat exchanger.

Do not operate with the input liquid off or disconnected. Liquid heat-exchanged units have a thermal overload switch on the heat exchanger. This switch blows the power supply output fuse during improper operation of the heat exchanger. However, its purpose is as a safety device and not an operational switch to permit chamber use without liquid flow.

Liquid coolant must be non-toxic and non-corrosive (e.g. water). Coolant below the minimum temperature will degrade the unit's specified performance.

Do not limit the liquid flow to regulate the detector temperature. It is strongly suggested that a liquid flow switch similar to the Imo Delaval model Gem FS-4 number 44715, together with Gem solid state switching unit Load-Pak number 20173, be installed in the output liquid line and wired to the power input of the cooler power supply. This flow switch is currently available worldwide.

⚠ TEMPERATURE CONTROLLERS

The auto-tuning function (A'U) is the only user-definable parameter in the controller. Do not change any other factory preset values without factory consultation. Changes in these values will void all expressed or implied warranties. Any questions regarding these values should be directed to the technical department at PFR Technologies, LLC.

SPECIFICATIONS

	STANDARD	MULTI-STAGE SERIES
1.	⚠ INPUT	
	115/230V, 50/60Hz (via voltage selector) 75 TO 115W (see Power Supply label)	115/230V, 50/60Hz (via voltage selector) 75 to 220W (see Power Supply label)
2.	OPERATIONAL	
	A. Minimum coolant water flow rate, 10 GPH	Minimum coolant water flow rate, 60 GPH
	B. Maximum coolant air or water, 40°C(110°F)	Maximum coolant air or water, 40°C(110°F)
	C. Minimum coolant air or water, 0°C(32°F)	Minimum coolant air or water, 10°C(50°F)
	D. $\Delta T > 40^{o}C$ (ambient coolant to photocathode)	$\Delta T > 50$, 60, or 70°C (depending on unit type)
3.	MECHANICAL	

⚠NOTE

DO NOT OVERTIGHTEN THE MOUNTING SCREWS OR USE SCREWS THAT EXTEND MORE THAN 5/16 INCH BEYOND THE MOUNTING SURFACE

A. Bottom Mounting: All units contain four bottom mounting holes which accept #10-32 screws to a maximum depth of 5/16 inch. Most units contain an additional four bottom mounting holes which will accept a 6mm x 1.0mm screw to a maximum depth of 12mm.

B. Front Mounting: All units are supplied with the appropriate Products For Research front mounting adapter, which is required for many accessories and useful in most applications. Adapters for specific equipment (e.g. monochromaters) are also available.

C. The window assembly retainer may be unscrewed and removed for interchange of the window or access to chamber, via the window opening.

D. Front entrance - the window retainer may be unscrewed and removed for interchange of window or front access to chamber

E. Outer case material - stainless steel (and painted or electroplated aluminum)

⚠ OPERATION

1. CONSULT THE DETECTOR INSTALLATION MANUAL BEFORE OPERATION.

2. REFER TO ALL WARNINGS LISTED ON PAGE 2.

3. Connect the multiple-lead cord(s) to the associated connector(s) between the chamber and power supply. Mating connectors are provided for high voltage and signal cables which must be attached to the socket assembly.

4. For units with the PR-201 (No-dew heated window retainer), plug the two connector jacks (non-polarized) into the mating pins in the front mounting ring side wall.

5. Plug the power supply cord into the power supply and an appropriate service outlet.

6. Turn the system on. The green power-on LED, temperature controller, or DC ammeter (depending on unit type) will indicate that the system is on.

7. With suitable high voltage and signal cables attached to the mating connectors provided with the unit, the detector can be energized.

8. (Steps 8 through 11 summarize operation for systems supplied with the option #36 temperature controller. This feature allows temperature regulation to within +/- 0.1°C, regardless of any changes in air or water temperatures. The microprocessor-based controller utilizes an "auto-tune" algorithm to automatically adjust PID parameters. Feedback is provided via a temperature sensor in the chamber. The front panel incorporates dual digital displays, indicating temperature of the present value and set point for the chamber. For detailed operation information, refer to the enclosed "Digital Controllers" instruction manual.)

9. Although factory-set and calibrated, initial operation may require setting the PID parameters to appropriate values, depending on the unit type, cooling medium, and environmental factors. In some situations, when operating conditions have been dramatically changed (e.g. ambient temperature or liquid flow rate change), it may be desirable to repeat the autotune function for maximum temperature stability.

10. Select an appropriate temperature set-point (minimum attainable temperature depends on the unit type and cooling medium).

11. If necessary, enable the "autotune' function to automatically calculate and program the PID constants:

- *Turn on the power. Enter the parameter setting mode by holding the SET/ENT key for approximately five (5) seconds.*
- *Advance through the parameters with the **SET/ENT** key until the autotune function (**A'U**) is reached.*
- *To start the autotune function, press the "up arrow" key until **0001** shows on the display. At this point the autotune function is engaged (to disengage the autotune function press the "down arrow" key to make the display read **0000**).*

- *Once the autotune is set, hold the **SET/ENT** key for approximately 5 seconds to return the controller to PV/SP mode (return is automatic if no action is taken for one minute). Confirmation of autotune activation is provided by a flashing green indicator light labeled **AT**. If at any time the autotune is to be aborted, either change the set point (SP) or proceed through the above process to the point where the display reads **0000**.*

The micro-processor will automatically cycle the unit three times above and below the temperature set point (note the flashing autotune indicator light). When the AT indicator light goes off, the constants have been set.

12. The cool-down time for the photocathode is typically two to three hours for air heat-exchanged thermoelectric units, or one to two hours for liquid heat-exchanged thermoelectric units, depending on the initial heat in the system.

⚠ NOTE

DO NOT OPERATE WITHOUT SOCKET ASSEMBLY AND/OR INSULATING WINDOW IN PLACE. REMOVAL OF THE WINDOW WHILE THE PMT IS ENERGIZED PRESENTS AN ELECTRIC SHOCK HAZARD. FURTHERMORE, IF THE SOCKET ASSEMBLY OR INSULATING WINDOW IS REMOVED DURING OPERATION, THERE WILL BE A TENDENCY FOR EXCESSIVE FROST TO FORM WITHIN THE CHAMBER WHICH IS DETRIMENTAL TO GOOD OPERATION, AND COULD THERMALLY SHOCK THE PMT.

⚠ TROUBLESHOOTING

The following information is intended to aid the user in the event of a simple problem. (Not all information is applicable to all systems.) Please consult PFR Technologies's technical assistance department for further assistance.

SYMPTOM:	**PROBABLE CAUSE (ACTION):**
A. T2A FUSE BLOWN (GREEN INDICATOR OR CONTROLLER IS OFF)	1. VOLTAGE INPUT MODULE SET TO INCORRECT LINE VOLTAGE DIGITAL (SET INPUT MODULE TO CORRECT LINE (MAINS) VOLTAGE)
	2. AC SECTION MALFUNCTION (CONTACT PFR)
B. F10A FUSE BLOWN (YELLOW INDICATOR IS ON)	1. INSUFFICIENT LIQUID FLOW OR EXCESSIVE TEMPERATURE - LIQUID HEAT EXCHANGED UNITS - OR INSUFFICIENT AIRFLOW OR EXCESSIVE TEMPERATURE - AIR HEAT EXCHANGED UNITS (CHECK FLOW AND/OR TEMP-ERATURE. IF OK, REPLACE FUSE. IF PROBLEM PERSISTS, CONTACT PFR)

C. WINDOW DEWING (UNITS W/NO-DEW ONLY)	1. HEATER JACKS NOT PLUGGED ONTO PINS ON CHAMBER (RECONNECT)
	2. HEATER TRANSFORMER OPEN CIRCUIT (CONTACT PFR)
D. EXCESSIVE FROST BUILD-UP INSIDE CHAMBER	1. FRONT WINDOW "O" RING OR REAR "O" RINGS NOT SEATED PROPERLY (INSPECT "O" RINGS - THEY MAY NEED TO BE **LUBRICATED*** AND REINSTALLED. IF DAMAGED, OR IF PROBLEM PERSISTS, CONTACT PFR)

EXTENDED OPERATION BAKE-OUT

Moisture should not accumulate within the chamber and/or socket assembly. However, this may occur if the components are repetitively internally subjected to ambient air. If this is the case (e.g. condition "D" above), or if the system is placed into storage, chambers and sockets should be subjected to a bake-out period to remove collected moisture:

1. Remove the window retainer and window cell.
2. Remove the socket assembly, and place the detector and the window cell in safe storage.
3. Disconnect the DC power supply controller (if applicable).
4. Place the chamber and the tube socket assembly in an oven for eight hours, with the temperature set at 40°C (104°F) maximum.

⚠NOTE

DO NOT EXCEED THE 40°C (104°F) MAXIMUM TEMPERATURE, OR THE FOAM INSIDE THE EQUIPMENT MAY EXPAND, VOIDING ALL WARRANTIES.

5. After bake-out, ***lubricate** all "O" Rings with silicone-based "O" Ring lubricant or vacuum grease, reassemble the chamber, clean the base of the detector when appropriate and return to operation.